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# Conservation Assessment of the Variegated Scouring Rush in the Black Hills National Forest, South Dakota and Wyoming

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of  
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## EXECUTIVE SUMMARY

Variegated scouring rush, *Equisetum variegatum* Schleich. ex F. Weber & D.M.H. Mohr, is a circumboreal, early seral, herbaceous facultative wetland species that occurs along streambanks, lake shores and in wetlands across the northern United States, Canada, and Alaska (USDA NRCS 2001; NatureServe 2001). Disjunct, isolated occurrences of variegated scouring rush in South Dakota, Utah, and Colorado may be relicts from the last Pleistocene glaciations. In Black Hills National Forest, variegated scouring rush is known only from Beaver Gulch in the Bear/Beaver Gulch Botanical Area. As a regional disjunct, boreal species, the Black Hills population is inherently less secure than populations in the core range of the species and may not be able to persist under warmer, drier climatic conditions in Black Hills National Forest. There do not appear to be any immediate risks to the currently known locations of the species, but their small populations and limited microsite habitats may make the species vulnerable to random stochastic events and human-caused disturbances.

Species specific surveys for variegated scouring rush have not been performed on Black Hills National Forest, and it may have a broader distribution than is presently recognized. The species and its potential habitat are under-surveyed in the Black Hills and there may be taxonomic problems relating to the species due to hybridization and confusion with *E. laevigatum*. There are significant information gaps for this species and its habitat in the Black Hills, and we can only begin to speculate on risks, and effects of various management activities. Additional information could include comprehensive surveys and inventories to better assess the range and distribution of variegated scouring rush on Black Hills National Forest. Documentation of known element occurrences could include mapping via GPS, estimates of colony size and density, and collection of other basic biotic and abiotic data such as geology, hydrology, associated species, and community types, etc.

Because so little is currently known about the ecology of these species, it is not possible to determine the degree of risk that disturbance and management activities present. Activities in and adjacent to the Botanical Area may have impacts or benefits. The basic management objectives for Bear/Beaver Gulch as a Botanical Area provide a good process-based conservation framework for minimizing risks to variegated scouring rush in Black Hills National Forest by promoting restoration of natural disturbances such as fire and beaver activity and restricting development activities that may impact botanical resources. Climate change (i.e., warmer, drier), continued expansion of upland conifer forests, water table declines, and absence of beaver habitat and populations may be the predominant natural risk factors. Conservation and enhancement of hydrologic resources throughout the watershed is essential, not only within the Botanical Area, but also on upstream areas of the Black Hills National Forest. Ongoing review of proposed project activities on upstream portions of the Black Hills National Forest will help to minimize potentially harmful activities that could jeopardize hydrologic resources within the watershed. This may include restricting future road access, livestock use, mineral development, and other resource disturbances such as water diversions, logging, road construction, etc. Ultimately, maintenance of beaver populations and natural disturbance processes (fire and flooding) in the drainage may be highly desirable to sustain this early seral facultative wetland species.

Key words: Variegated scouring rush, *Equisetum variegatum*, beaver ecology, Black Hills.

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## INTRODUCTION

The objectives of this assessment are to review the status of variegated scouring rush in the Black Hills and to synthesize information relevant to its management and long-term persistence. There is little information about the habitat needs of variegated scouring rush and its responses to management activities in the Black Hills. The result is a fairly low state of knowledge about the local requirements of this species. In addition to published literature on variegated scouring rush and its habitats, other sources of information were important in developing this assessment. The USDA, NRCS PLANTS Database is referenced frequently in this document, although the geographical basis and source of specific habitat data is often unknown and may not be directly applicable to the Black Hills in all instances. This document was developed in accordance with content and format requirements defined by Black Hills National Forest.

Variegated scouring rush, *Equisetum variegatum* Schleich. ex F. Weber & D.M.H. Mohr, is a perennial, herbaceous, facultative wetland species (FACW<sup>+</sup>) that occurs in Alaska, across Canada, from Newfoundland to British Columbia, and across the northern portion of the United States, extending south to Utah, Colorado, Illinois, and Indiana (Figure 1) (Cronquist *et al.* 1986; USDA NRCS 2001; NatureServe 2001). Across the species' range, its conservation status varies from secure in northern boreal regions to imperiled or critically imperiled due to extreme rarity in southerly disjunct populations (NatureServe 2001). Variegated scouring rush is a "species of special concern" with the South Dakota Natural Heritage Program due to rarity (Ode pers. comm. 2001). The rare occurrences in the Great Plains, Black Hills, and Rocky Mountains are likely relicts from the last Pleistocene glaciation 11,000 years ago (Froiland 1962).

The only currently known occurrence of variegated scouring rush ever reported in the Black Hills is in a steep, narrow valley bottom portion of the Beaver Gulch drainage in the northern Black Hills (SDNHP 1989).

## CURRENT MANAGEMENT SITUATION

### Management Status

#### *International*

Global Heritage Status Rank: G5; secure worldwide, but possibly quite rare in parts of its range, especially at the periphery (NatureServe 2001).

#### *Federal*

Variegated scouring rush has no special federal status and is not a designated "Sensitive" species in USFS Region 2 (USDA Forest Service 1994) or "Special Status" plant species by the BLM (USDI BLM 1997).

Variegated scouring rush is a circumboreal species associated with wet meadows, streambanks, and shores, from the lowlands to fairly high elevations in the mountains (BONAP 2001; Cronquist *et al.* 1986; Hitchcock *et al.* 1969). As expected, variegated scouring rush is rare

where wetlands are less abundant or human impacts are more widespread. In addition, human activities have directly and indirectly impacted the quality, quantity, and distribution of variegated scouring rush's wetland habitats. Accordingly, variegated scouring rush is imperiled to vulnerable (S2S3) in Wyoming, and critically imperiled due to extreme rarity (S1) toward the southern limits of its range in South Dakota, Utah, and Colorado, while populations in Maine and Canadian provinces are generally more secure (NatureServe 2001).

A single known population of variegated scouring rush occurs on Black Hills National Forest (BHNH), in the Bear/Beaver Gulch Botanical Area (SDNHP 1989). This area was given administrative designation as a Botanical Area in 1997 (USDA Forest Service 1997). Under this direction, the Botanical Area is to be managed to prevent impairment of the attributes for which it was established. The primary values for which the area was designated were the unique botanical features, including variegated scouring rush. Further management related discussions are presented in REVIEW OF TECHNICAL KNOWLEDGE, Response To Habitat Changes – *Management Activities* and REVIEW OF CONSERVATION PRACTICES, Management Practices.

### ***Conservation Status***

<b>State</b>	<b>RANK</b>	<b>COMMENTS</b>	<b>SOURCE</b>
South Dakota	S1	Critically imperiled due to extreme rarity	NatureServe 2001; SDNHP 1989

### ***Conservation Status - Elsewhere***

<b>State/Province</b>	<b>Rank</b>	<b>Comments</b>	<b>Source</b>
U.S.			
Colorado	S1	Critically Imperiled	NatureServe 2001
Wyoming	S2S23	Imperiled - Vulnerable	NatureServe 2001
Indiana, New Jersey, North Dakota, Pennsylvania, South Dakota, Utah	S1	Critically Imperiled	NatureServe 2001
New Hampshire, Ohio	S2	Imperiled	NatureServe 2001
Illinois	S2S3	Imperiled - Vulnerable	NatureServe 2001
Connecticut, Massachusetts, Wisconsin	S3	Vulnerable	NatureServe 2001
Maine	S4	Apparently Secure	NatureServe 2001
Alaska, Idaho, Minnesota, Montana, Nebraska, New York, Oregon, Vermont, Washington	SR	Reported	NatureServe 2001
Michigan	S?	Unranked	NatureServe 2001
Canada			
Brunswick	S2	Imperiled	NatureServe 2001
Nova Scotia	S3	Vulnerable	NatureServe 2001
Alberta, Manitoba, Ontario	S5	Secure	NatureServe 2001
British Columbia, Labrador (Newfoundland), Newfoundland Island (Newfoundland), Northwest Territories, Nunavut, Quebec, Yukon Territory	SR	Reported	NatureServe 2001
Saskatchewan	S?	Unranked	NatureServe 2001
Prince Edward Island	SU	Unrankable	NatureServe 2001

## Existing Management Plans, Assessments Or Conservation Strategies

No other management documents were identified for variegated scouring rush.

## REVIEW OF TECHNICAL KNOWLEDGE

### Systematics

Citation: Schleich. Ann. Bot. (Usteri) 21: 124. 1707, nom. nud.; ex F.Weber & D.M.H. Mohr, Deuts. Crypt. Gewachse 60: 447. 1807.

There are 13 *Equisetum* species in South Dakota, including two hybrids, and two varieties (Biota of North America Project 2001). Variegated scouring rush, *Equisetum variegatum* Schleich. ex F.Weber & D.M.H. Mohr, is classified as Division Equisetophyta, Class Equisetopsida, Order Equisetales, Family Equisetaceae (Scouring Rush or Horsetail Family), Genus *Equisetum*, Subgenus *Hippochaete* (BONAP 2001; Walters and Keil 1996). Two varieties have been recognized, *E. variegatum* var. *variegatum* Schleich. ex F.Weber & D.M.H. Mohr, and *E. variegatum* var. *alaskanum* A. A. Eat. (ITIS 2001).

The South Dakota occurrence belongs to var. *variegatum*, which is represented across inland occurrences in North America. The more robust var. *alaskanum* is restricted to coastal regions of Alaska, Washington, Oregon, British Columbia, and Yukon Territory (BONAP 2001). According to Great Plains Flora Association (1986), *Equisetum variegatum* has been confused with depauperate material of *E. laevigatum* in the region. Two sterile hybrids have been reported. *E. x nelsonii* (A. A. Eat.) Schaffner, Amer. Fern J. 16: 46. 1904, involving *E. variegatum* and *E. laevigatum*, has been collected from the Uinta Mountains and Bear River Range of northern Utah. *E. x trachyodon* A. Br. Flora 22: 205. 1839, is the resulting hybrid between *E. variegatum* and *E. hyemale* (Cronquist *et al.* 1986). The Heritage Identifier for variegated scouring rush (*Equisetum variegatum* Schleich. ex F.Weber & D.M.H. Mohr,) is PPEQU010B0. Both *E. laevigatum* and *E. hyemale* are known from the Black Hills. See REVIEW OF TECHNICAL KNOWLEDGE, Demography - *Survival and Reproduction* for related discussion.

### Species Description

#### *Non-Technical*

*Equisetum* is a primitive, very distinctive genus, readily recognized by the combination of jointed, ribbed, and hollow stems (Walters and Keil 1996). Variegated scouring rush is a relatively small and slender, short-lived (e.g., several years) perennial species of *Equisetum*. The basally-branched, evergreen, 5 to 10 grooved stems with a central cavity one third of the stem diameter, and persistent white-margined teeth on the sheaths distinguish variegated *scouring* rush from other Black Hills *Equisetum* (Rydberg 1965). *Equisetum variegatum* is a member of the group without stems regularly branched in whorls.

#### *Technical*

“Stems evergreen, from black, smoothish rhizomes, all alike, ascending or erect, 1-3 dm. tall, 1-2



(3) mm. thick, branched near the base, 5- to 12-ridged, the ridges very shallowly furrowed and with two rows of tubercles, the stomates in two rows in each principal furrow, sunken below the level of the epidermis; central cavity 1/4 to 1/3 the diameter of the stem, mostly larger than the 5-12 vallicular ones; sheaths mostly 2-4 mm. long, poorly marked at the base, slightly flared upwards, green, with an apical black or blackish band, the body of each tooth 1-2 mm. long, with a black or blackish, 2-ridged midstripe and conspicuous white-hyaline margins, rather abruptly contracted to a hairlike, deciduous tip 0.5-1 mm. long; cones small, scarcely 1 cm. long, short-pedunculate, apiculate.” (Hitchcock *et al.* 1969).

## **Species Significance**

Although it ranges across the northern portion of the continent, variegated scouring rush is present in Region 2 as widely scattered occurrences, except in western Wyoming where it is fairly widespread. In the Black Hills, and all of South Dakota, it is currently only known from a single drainage, Beaver Gulch, in the northern Black Hills, but this is likely due to limited surveys for the species, and it likely occurs elsewhere (SDNHP 1989). As the only currently known occurrence of variegated scouring rush in the state, this population may be an important source of genetic diversity although this has not been documented.

Many *Equisetum* species possess abrasive qualities due to silicon dioxide crystals in epidermal cells. *E. hyemale* was used by early settlers to clean pots and pans, thereby earning the common name, scouring rush (Walters and Keil 1996). Stems of *E. hyemale* have also been sold as a tea in health food stores (Walters and Keil 1996). *Equisetum* has little economic importance and there is no record for the use of variegated scouring rush as an ornamental species or for other commercial purposes (Walters and Keil 1996).

## **Distribution And Abundance**

Variegated scouring rush is known from Alaska, south and east through the boreal forest and northern prairies of Canada and northern United States (Welsh 1973). The species is secure throughout its range with a G5 ranking, but infrequent across much of the U.S. with Region 2 state numerical rankings ranging from S1, critically imperiled; to S2S3, imperiled to vulnerable (NatureServe 2001). While it is fairly widespread throughout western Wyoming, variegated scouring rush approaches the southern end of its range in the Black Hills, Utah, and Colorado, where it generally occurs as scattered, disjunct populations (Albee *et al.* 1988; Spackman pers. comm. 2001; NatureServe 2001; University of Wyoming 1998). Species commonly become infrequent at the edges of their range, most often due naturally to their habitat components becoming less available. The first documented report of variegated scouring rush in South Dakota was in 1989 in the northern Hills, Beaver Gulch on Black Hills National Forest (SDNHP 1989).

## ***Distribution Recognized In Primary Literature***

The Black Hills were not glaciated during the Pleistocene era, and are known to have supported vegetation during that cooler and wetter period when coniferous forests may have linked the Hills with surrounding areas, including the Rocky Mountains to the west (Froiland 1999). The apparent preference of variegated scouring rush for cool, moist sites, and its distribution across the northern portion of the continent is consistent with a species that may have ranged farther

south and at lower elevations during the Pleistocene. As the climate became warmer and drier, such relict species became more restricted and isolated in their range and were limited to relict habitats such as boreal remnants found within the Black Hills. Variegated scouring rush occurs in boreal woods, bogs, wet meadows, and on streambanks and shores from Newfoundland to British Columbia and the Northwest Territories, and south to Illinois, Utah, and Colorado; but is most common in central Canada (NatureServe 2001; USDA NRCS 2001; Welsh 1973). In Alaska, variegated scouring rush also occurs on scree slopes, tundra, and in the alpine zone (Hulten 1968). The species' distribution is presumably due to its dependence on wetlands and other aquatic resources such as streambanks and shores of lakes and ponds. Its scattered distribution in the Rocky Mountains, Black Hills, and Great Plains is likely the result of the geographic isolation of wetland habitats in these regions during the current inter-glacial drying trend (Froiland 1962). The species could have been more widespread historically, but this is not documented in the literature.

In Montana, variegated scouring rush occurs in moist areas in western and south-central portions of the state (Dorn 1992). In Wyoming, the species is not tracked by the state Heritage Program (Fertig pers. comm. 2001), but the species is reported to occur in sites across the western and central part of the state (Dorn 1994). The Atlas of the Flora of Wyoming (Figure 2) depicts the nearest variegated scouring rush occurrence in Converse County in the vicinity of Thunder-Basin National Grassland. Remaining occurrences are noted in Park, Sublette, Teton, Lincoln, Sweetwater, and Fremont counties (University of Wyoming 1998).

In Utah, Welsh (1993) indicates the species is to be expected in Utah, but others have reported occurrences restricted to the southwestern portion of the state, with one outlier noted for Grand County on the Colorado Plateau (Albee *et al.* 1988).

Previous reports of variegated scouring rush in Kansas, Nebraska, North Dakota, South Dakota, and Oklahoma were based on depauperate (e.g., small) specimens of *E. laevigatum*, that were initially mis-identified as *E. variegatum* (Great Plains Flora Association 1986).

In addition to a possible preference for limestone suggested by the Black Hills EO, variegated scouring rush is reported to be strictly limited to outcrops of a marl layer at the base of the Orval Limestone in parts of France (Parent 1991).

Surveys for additional occurrences of variegated scouring rush are conducted on an ongoing, project-oriented basis in the South Dakota and Wyoming portions of Black Hills National Forest. However, at this point, the long-term persistence of variegated scouring rush in the Black Hills is entirely dependent upon the continued survival of the population in Beaver Gulch. The species' ability to disperse elsewhere in the Black Hills may be determined by the quality and extent of suitable habitat, presumably cool, moist microenvironments, possibly in association with limestone outcrops.

#### ***Additional Information From Federal, State, And Other Records***

In Colorado, the species is tracked by the state Heritage Program, with three documented Element Occurrences (EO's) (Spackman pers. comm. 2001).

In South Dakota, the sole EO record for variegated scouring rush is along an intermittent stream channel in Beaver Gulch, a narrow, steep-walled drainage with a northerly aspect (SDNHP 1989). The localized colony was reported to occur on a seepage area below a limestone outcrop

several feet above the creek bottom. During a site reconnaissance visit as part of the background for preparation of this report, an additional colony was observed in the intermittent channel bed of Beaver Gulch in the general vicinity of the documented EO (Figures 3 & 4) (Glisson pers. obs. 2001). No EO record was filed for the new colony and no further attempt was made to relocate the original population referenced in the South Dakota Natural Heritage Program EO.

### ***Local Abundance***

There is currently only one reported EO record for variegated scouring rush in South Dakota, in the northern portion of the Black Hills, in Beaver Gulch. Another colony of variegated scouring rush in the same general vicinity (e.g., estimated within about 1/4<sup>th</sup> mile of documented EO) was observed during a field visit in support of preparation of this document, but no EO record was filed and no voucher specimen was collected (Glisson pers. obs. 2001). The restricted occurrence of variegated scouring rush in the Black Hills may be due to naturally limited habitat availability (Ode pers. comm. 2001). However, no surveys have been performed specifically for variegated scouring rush and its distribution and abundance in BHNH may be more extensive than is presently known (Marriott pers. comm. 2001).

### **Population Trend**

No specific population trend monitoring data is available for variegated scouring rush in Black Hills National Forest and the EO hasn't been resurveyed since it was first reported in 1989 (Ode pers. comm. 2001).

### **Broad Scale Movement Patterns**

The Black Hills populations of variegated scouring rush are over a hundred miles away from the nearest populations, which are in central Wyoming. Once airborne, variegated scouring rush spores may be expected to travel considerable distances, and natural transfer of spores from other variegated scouring rush populations is possible. Export to other suitable habitat is also possible, especially on a localized basis, and additional colonies may be expected to occur in other drainages on the northern portion of the Black Hills. Water transport of spores and/or rhizome fragments is conceivable, although not documented, on a localized basis, but not likely as a means of long range transport, especially in the absence of direct transfer routes. Migratory birds or insects may represent another likely, but undocumented mode of transfer of spores and/or rhizome fragments. It is unknown if the disjunct Black Hills population of variegated scouring rush is an important source of genetic diversity. If the Black Hills population was extirpated, it is questionable if natural recolonization would occur.

### **Habitat Characteristics**

Variegated scouring rush is a facultative wetland species (USDA NRCS 2001) that occurs predominantly in boreal regions, where it occupies meadows, swamps, lakeshores, seeps, and stream banks at low to high elevations (Hitchcock *et al.* 1969; Welsh 1973; Great Plains Flora Association 1986; Rydberg 1965; Cronquist *et al.* 1986). Based on available distribution records and habitat descriptions, variegated scouring rush appears to be at least occasionally associated with limestone substrates (Parent 1991; SDNHP 1989). In the Black Hills, variegated scouring rush is known from a cool, shaded, seep at the base of a limestone outcrop (SDNHP 1989). An

additional colony is located in the same general vicinity, within the confines of the intermittent channel of Beaver Gulch (Glisson pers. obs. 2001). The in-channel colony presumably accesses water directly from the creek when it is flowing and from the shallow alluvial aquifer during drier periods. Beaver Gulch probably functions as a cold-air drainage, further enhancing the cool, moist microclimate in localized areas.

Soils in this area are mapped as the Vanocker-Citadel association and consist of steep well drained soils of low fertility, characterized by rapid runoff. Although the EO makes reference to a seep at the base of a limestone outcrop, it is not clear if the species is closely associated with limestone in the Black Hills (Ode pers. comm. 2001). The soil type at the “seep site” would be an inclusion to the soil association, and could have different characteristics than what is described for the major soils of the association.

Variegated scouring rush is reportedly an early seral species adapted for fluvial disturbance, which may provide an important mechanism for its ongoing recruitment (Fyles and Bell 1986; Helm and Collins 1997). In Alaska, variegated scouring rush was reportedly the earliest vegetation type to occupy silty sites along the floodplain of the Susitna River (Helm and Collins 1997). In British Columbia, variegated scouring rush reportedly occurs in silt channels along the Blaeberry River where water table depths average 46 cm (range 30 to 55 cm), and the inundation frequency is estimated at once every two to four years (Fyles and Bell 1986). Variegated scouring rush remained a common understory component of late seral riparian forest communities (paper birch (*Betula papyrifera*) and white spruce (*Picea glauca*). This was apparently due to re-colonization of raw substrate exposed by periodic flooding events after later seral understory species were removed by scouring (Helms and Collins 1997). This suggests variegated scouring rush is shade tolerant, but a poor competitor, at least with certain other understory species. It also suggests that on-going recruitment of variegated scouring rush is dependent on physical disturbance. In Colorado, habitat preferences are listed as sandy soils ranging from neutral to slightly alkaline, in wet meadows, bogs, alluvial thickets, and sandy soil of riverbanks, ditches and lakes, at elevations from 9450 to 11200 feet, in (CNHP 2001). It reportedly occurs in riparian and other moist habitats in blackbrush (*Coleogyne ramosissima*), sagebrush (*Artemisia* sp.), greasewood (*Sarcobatus vermiculatus*), pinyon-juniper, mountain brush, spruce-fir, and lodgepole pine (*Pinus contorta*) communities (CNHP 2001).

The direct effect of fire as a disturbance factor on variegated scouring rush in Beaver Gulch is unknown. Ponderosa pine (*Pinus ponderosa*) dominates the slopes of Beaver Gulch canyon, and ironwood (*Ostrya virginiana*) is prevalent across the valley bottom and lines the creek channel in some areas. Ponderosa pine is known to have expanded its coverage throughout the area as a result of fire prevention in the Black Hills over the last 120 years. The encroachment of pine forests as a result of fire suppression and resulting reduction in overall water yield on a landscape scale may be responsible for loss of suitable variegated scouring rush habitat in the area, or it might have always been rare in the post-Pleistocene environment.

Variegated scouring rush's habitat requirements in this portion of its range may be influenced by arid conditions or other factors (i.e. temperature) and may be different from its habitat requirements to the north where the species occurs across a broader array of wetlands, lakeshores, and streambanks (Hitchcock *et al.* 1969; Cronquist *et al.* 1986; Ode pers. comm. 2001). Unoccupied potential habitat for variegated scouring rush may occur in the Black Hills and in the intermediate areas between populations along the Rocky Mountains from Wyoming,

Colorado, and southern Utah. The reasons for the species' absence from otherwise suitable habitat may be due to highly specific micro-site requirements, dispersal limitations, the absence of disturbance that facilitates plant establishment, or habitat needs that have yet to be discovered.

The literature contains no specific references to competitive interactions that would limit the distribution of variegated scouring rush in any portion of its range. Considering its location in Beaver Gulch and occurrence in the understory of Alaskan floodplain forests, variegated scouring rush appears to be shade tolerant, a limiting factor for some early seral species. Because variegated scouring rush prefers moist habitats, some interspecific competition with other wetland species is likely. Variegated scouring rush is presumably subject to the same risks as other native wetland plants from competitive exclusion by invasive wetland weed species. The primary ecological stressors to variegated scouring rush appear to be impacts to local hydrology, competition, and probably temperature limitations.

The species' limited distribution may be partially due to the cumulative effects of human activities on wetlands and the resulting trend toward reduced and geographically isolated wetland habitats. Overall, it appears that the species' distribution is facilitated by a combination of hydrologic and microenvironmental conditions and a source of periodic physical disturbance.

## **Demography**

### ***Life History Characteristics***

Variegated scouring rush is a rhizomatous, perennial, facultative wetland, herbaceous species associated with wetlands, streambanks, and lakeshores across its range (Hitchcock *et al.* 1969; Cronquist *et al.* 1986; USDI FWS 1988). It presumably has at least moderate tolerance to anaerobic conditions, and may be associated with limestone substrates in portions of its range (Parent 1991, SDNHP 1989).

The sporophyte generation is the most evident and familiar growth form over the life cycle of *Equisetum*, occurring alternately with the gametophyte generation. Sporophytes produce numerous short-lived spores, with two sets of thread-like hygroscopic attachments, termed elators, believed to aid in dispersal (Hauke 1963). Spores may germinate within 24 hours if suitable conditions are available, but remain viable for 5 to 17 days, depending on humidity. The time required for germination increases with time after dispersal. Even in the presence of high humidity, high respiration limits spore viability. Sporophytes are believed to be allelopathic, which may explain an apparent low incidence of gametophytes in existing sporophyte stands (Hauke 1963). Spores give rise to gametophytes, which although easily overlooked, may be very common and occur in considerable numbers under favorable conditions (e.g., mud flats around reservoir margins) (Duckett and Duckett 1980). *Equisetum* gametophytes typically have extremely narrow habitat tolerances, requiring the availability of bare, moist substrate coincident with spore production and release (Duckett and Duckett 1980). *Equisetum* gametophytes typically reach sexual maturity in three to five weeks and then produce a constant supply of gametes for the remainder of their life span, often until the end of the growing season if suitable moisture conditions persist (Duckett and Duckett 1980). Gametophytes may be male, female, or bisexual, and sex ratios vary in response to environmental conditions. Release of sperm from antheridia requires water or high humidity conditions (Hauke 1963). There is typically a high incidence of fertilized archegonia (female gametophytes) regardless of the proportion of male

gametophytes (sperm produced in antheridia) which often occur in widely spaced, low density distribution patterns (Duckett and Duckett 1980). Despite the apparent allelopathy mentioned earlier, stands of *Equisetum* sporophytes are often highly heterogeneous, suggesting a high degree of sexual reproduction via gametophytes. This has been further evidenced via the development of two hybrids where mixed gametophyte populations were observed over a four year study period (Duckett and Duckett 1980).

As in all species of the subgenus *Hippochaete*, strobili are borne on photosynthetic shoots of the sporophytes. According to Hauke, (1963), many stems with young cones overwinter, and cones release their spores as they expand in the spring and early summer. New shoots emerge in July and August, some bearing cones and shedding spores in August and July, but most cones not expanding until the following growing season. The tendency for young cones to overwinter increases with more northerly populations, presumably due to the shorter growing season.

In variegated scouring rush, there is considerable variability in stem size, with more robust specimens approaching *E. hyemale* in size and smaller specimens ranging toward the size of *E. scirpoides*. There is reportedly a direct correlation between stem size and mean annual temperature for an area (Hauke 1963).

Hybridization is common in some *Equisetum* species, and variegated scouring rush reportedly may form hybrids with two widespread species that also occur in Black Hills NF, *E. laevigatum* and *E. hyemale* (Marriott 1985). Neither of the resulting hybrids, *E. x nelsonii* (A. A. Eat.) or *E. x trachyodon* A., are known from South Dakota. Variegated scouring rush reportedly does not hybridize with *E. scirpoides*, even where the two species are sympatric (Hauke 1963). *Equisetum* hybrids are always infertile as a result of abortive spores (Hauke 1963).

### ***Survival And Reproduction***

As in all *Equisetum*, variegated scouring rush may reproduce either vegetatively via rhizomes or sexually through alternate generations of sporophytes and gametophytes (Walters and Keil 1996). The rhizomes of some species of *Equisetum* may extend hundreds of square feet, and extend to depths of six or seven feet, allowing individual plants to withstand acute drought stress (Hauke 1963). Vegetative reproduction provides an important mode of survival and reproduction in many species of *Equisetum*.

According to Duckett and Duckett (1980), “the most critical factor for sexual reproduction in *Equisetum* appears to be the initial establishment of spores”. The high degree of heterogeneity indicates a high degree of out-crossing during reproduction. In general, spores may be expected to be more effectively dispersed over wider ranges than fertilized archegonia (Duckett and Duckett 1980).

The present geographic isolation of Black Hills’ variegated scouring rush populations from the nearest locations in Wyoming, Colorado, and Montana would appear to prohibit any interbreeding between them, although there is the possibility of spore or vegetative propagule transfer via birds or air masses.

### ***Local Density Estimates***

Population estimates for variegated scouring rush are not available beyond the EO reference to a localized colony, although based on a recent field visit, at least one additional colony, localized

patches scattered over an area approximately 12 to 20 square meters, was observed in the vicinity (SDNHP 1989; Glisson pers. obs. 2001).

### ***Limiting Factors***

Variegated scouring rush's apparent affinity for cold, moist, sheltered sites possibly in association with limestone may be a major limiting factor since these features are relatively uncommon in the Black Hills. The species exists as a limited remnant population of a northern boreal species, and may not be able to persist under current or future (i.e., warmer, drier) climatic conditions in the Black Hills. In addition, in this portion of variegated scouring rush's range, the distribution and character of riparian and wetland habitats are strongly influenced by fire, flooding, and beaver-created disturbances (Parrish *et al.* 1996). Wetland habitats for disturbance-dependent or early seral species are often enhanced by the removal of encroaching conifers, increased groundwater flow from scorched uplands, and by the flooding, sediment deposit, and other disturbances created by beaver during dam building. These disturbances may be important to variegated scouring rush's long-term viability in the Black Hills, and to its ability to occupy potential habitats, but no specific information is available in the literature, and the precise role of fire in Black Hills ecology remains a controversial topic. The role of beaver in the local ecology is also questionable, as the sole known occurrence does not appear to be directly associated with beaver activity. However, beaver activity at upstream locations on Beaver Gulch and its tributaries presumably benefits hydrologic conditions throughout the watershed by enhancing base flows and water tables in downstream areas (Reeck pers. comm. 2001).

It is possible that variegated scouring rush was more widely distributed prior to European settlement, and the disjunct and isolated distribution that exists today is in part due to human impacts on the abundance and distribution of wetland habitats in North America. In the Black Hills, Great Plains, and Rocky Mountains, the natural disturbances that benefit wetland species, such as fire and beaver activity, have also been reduced or eliminated (Parrish *et al.* 1996). At the same time, timber production, mining, livestock use, agricultural use, and reduction or local extirpation of beaver since the late 1800's have resulted in a sharp downward trend in the quantity and distribution of wetland species (Parrish *et al.* 1996).

### ***Metapopulation Structure***

The known metapopulation of variegated scouring rush in the Black Hills is comprised of the single population (two apparent colonies with two different site characteristics, i.e. seep versus streamside) in Beaver Gulch. It is not known if there is any genetic exchange between other locations in the region, but it is not likely since the nearest known populations to the Black Hills are at least 100 miles distant. Since the species has likely persisted in the area since the last ice age and may be more widespread than is currently known, the metapopulation may be relatively stable through time.

However, as a regional disjunct, the Black Hills population is inherently less secure than populations in the core range of the species. If the population in the Black Hills area were extirpated, it is unlikely that natural recruitment from other extant stands would occur.

### ***Propagation Or Cultivation***

Variegated scouring rush may be propagated from rhizomes or spores, although the latter approach requires a narrower range of available conditions (Duckett and Duckett 1980).

## **Community Ecology**

### ***Browsers Or Grazers***

Animal herbivores, including barren-ground caribou in the Northwest Territories of Canada (but not known from the Black Hills), may utilize variegated scouring rush (Thomas and Kroeger 1981). Many species of *Equisetum* are reportedly toxic to cattle (Walters and Keil 1996).

Beyond selective pressures from livestock use, trampling might be expected to adversely impact variegated scouring rush. Direct physical disturbance and transport of noxious weed propagules by livestock may pose an additional risk to variegated scouring rush habitat, but may also serve to provide establishment sites through elimination of existing vegetation and possibly breaking of viable rhizome fragments that may be transported elsewhere, although this is not known. Livestock use in drainage bottoms is identified as a possible activity in Beaver and Bear Gulches although access to the valley bottoms is unlikely due to steep side slopes (*USDA Forest Service* 1997; Reeck pers. comm. 2001).

### ***Competitors***

*Equisetum* are generally early seral species and would not be expected to compete well with invasive wetland weeds such as Canada thistle and purple loosestrife that may disrupt wetland ecosystems by rapidly overtaking and out-competing native species. Weed treatments can be detrimental to native vegetation, although herbicides used to treat broadleaf noxious weeds likely have little to no effect on *Equisetum* and may benefit the species by reducing competition. Noxious weeds further alter wetland ecosystems by reducing or eliminating the structural diversity and microhabitats that comprise native plant communities. Noxious weeds may adversely impact variegated scouring rush and its habitats. No noxious weeds were observed in immediate proximity to the variegated scouring rush occurrence in Beaver Gulch (Glisson pers. obs. 2001). Encroachment by later successional species may displace variegated scouring rush plants that might otherwise persist indefinitely under favorable hydrologic conditions.

### ***Parasites, Disease, And Mutualistic Interactions***

One study of variegated scouring rush found no mycorrhizal associations (Treu *et al.* 1996), which may be consistent with an early seral, pioneering species (Fyle and Bell 1986; Helm and Collins 1997). No diseases or parasites are known based on available literature.

### ***Other Complex Interactions***

Beaver may indirectly facilitate the establishment and persistence of variegated scouring rush by augmenting natural flood disturbance and saturated wetland conditions and through creation of exposed sediment areas that may provide recruitment opportunities for *Equisetum* (Olson and Hubert 1994), particularly in the arid western portions of the species' southern range limits. Even in more mesic, boreal regions of North America, beaver exert a strong influence on the quantity and quality of wetland habitats (Naiman *et al.* 1988). For this reason, it is possible that the metapopulation dynamics of variegated scouring rush in the Black Hills are linked to the



recent or historic distribution and abundance of beaver. However, the only known Black Hills population does not appear to be directly influenced by beaver and historical beaver activity in the immediate vicinity was probably limited due to the relatively high stream gradient along this reach. In general, beaver may provide long-term benefits to variegated scouring rush by creating and enhancing wetland habitats, and by altering hydrology by elevating base flows and water tables.

The successional relationships and disturbance ecology of variegated scouring rush in the Black Hills are not well understood at this time. Both biotic and abiotic disturbances may play a significant role in the distribution and abundance of variegated scouring rush. Natural disturbances such as periodic insect outbreaks and fire benefit the species by the increased groundwater flow that results from the death of upland trees. Fire may also serve to maintain the open character of wetland habitats and facilitates the regeneration of hardwoods favored by beaver. By damming and flooding lowlands in the headwater reaches of Beaver Gulch, beaver may help to dampen the effects of extreme drought periods, augment base flows in downstream portions of the watershed, expand wetlands and create both large and small-scale soil disturbance (Olson and Hubert 1994). Once forage has been depleted in an area, beavers relocate to another section of the stream, thereby creating a mosaic of wetland habitats (Naiman *et al.* 1988; Parrish *et al.* 1996). These actions may indirectly and directly create and/or enhance habitats and provide recruitment opportunities for variegated scouring rush and other species. Variegated scouring rush may colonize recently deposited or disturbed soils and may sprout from existing rootstocks. In general, natural disturbances that reduce upland tree densities, or facilitate hardwood regeneration and thereby beaver activity, will likely enhance variegated scouring rush's occupied and potential habitats. Similarly, management activities that mimic the natural disturbances described above, such as prescribed fire or thinning of upland forests, may also be expected to enhance other potential variegated scouring rush habitats in the Black Hills and elsewhere.

In general, variegated scouring rush would likely benefit through protection of the existing population and implementation of management activities that may increase the quantity and quality of available habitat. Many of these approaches are consistent with existing Black Hills management objectives through restoration of natural disturbance factors, including the use of fire in a localized manner and recovery of beaver populations in selected areas.

## **Risk Factors**

Because variegated scouring rush is a facultative wetland species that may require soil disturbance for initial establishment, factors that reduce water yield or that reduce or eliminate flooding, beaver activity, and fire, may have negative effects on its long-term persistence in the Black Hills. Direct disturbances from logging, trail, road, or highway construction, livestock use, mining, or off-road vehicle use may either offer benefits by providing recruitment opportunities or be potentially detrimental to variegated scouring rush and the structure and integrity of its potential habitats, depending on the timing, scope, and magnitude of the disturbance in concert with natural climatic variability. However, no new roads are permitted in Botanical Areas, and new trails are not constructed, unless they are needed for interpretive or educational purposes or to correct resource damage currently occurring. Road construction and off-road vehicle use are not significant risk factors for the currently known occurrence of variegated scouring rush, but may pose risks to potential habitat or yet-to-be-discovered

populations in other areas. Logging activities and prescribed burns in the vicinity of the steep-walled canyons of Beaver and Bear Gulches may result in “flashier”, i.e., higher storm runoff, and greater physical disturbance. This may offer benefits by creating new areas of potential habitat for scouring rush, but may also increase the risk of damaging or destroying the existing population, depending on the severity of subsequent storm events.

Noxious weeds and other invasive species may pose a risk to variegated scouring rush, and may also restrict the ability of the species to disperse into other wetland habitats. Prolonged regional warming and or drying trends may increase the risk to variegated scouring rush populations if site hydrology and microenvironmental conditions are sufficiently altered.

## **Response To Habitat Changes**

### ***Management Activities***

#### **Timber Harvest**

The upper slopes of much of Bear and Beaver Gulches within the Botanical Area were logged during the 1990's, but the area is presently outside the timber base so it will not likely be logged any further (Reeck pers. comm. 2001). Logging of these upslope areas may be expected to enhance water yield within the watershed, and affect runoff and flooding patterns within the canyons. As discussed earlier, these activities may either provide potential benefits or adverse impacts to variegated scouring rush, depending on the severity of storm and runoff events, and the extent of reduced cover as a result of logging and road building activities.

#### **Recreation**

Recreational impacts associated with off-road vehicles and snowmobiles are not likely to impact the currently known population of the species at present due to the steep terrain and limited potential for accessing the canyon bottom at this time (Reeck pers. comm. 2001). Future expansion of public access by trails, though not planned at this time, is permitted under the Forest Plan (USDA Forest Service 1997) and would need to be designed to avoid risks to the currently known occurrence of variegated scouring rush.

#### **Livestock Grazing**

Livestock may impact streamside communities through trampling, resting, and trailing (Hoffman and Alexander 1987). Livestock may directly impact variegated scouring rush by trampling plants, and indirectly by altering the microtopography and nutrient dynamics of the species' habitats (USDA Forest Service 2000). The steep side slopes of Beaver gulch would tend to cause cattle to congregate in the valley bottom, potentially accentuating trampling and physical disturbance of the variegated scouring rush population.

#### **Mining**

Physical disturbance associated with mining activities and associated road construction may pose a risk if located in the immediate vicinity or upstream of the known variegated scouring rush population. Mining is permitted within the Bear/Beaver Gulches Botanical Area, but no mining projects are planned at this time (Reeck pers. comm. 2001). In addition, the Botanical Area may

be withdrawn from future mineral entry if necessary to protect the botanical resources (Reyher pers. comm. 2001). In general, mining poses a very minimal risk to the currently known occurrence of variegated scouring rush.

### **Prescribed Fire**

Management activities exert a strong influence on wetland hydrology throughout the Black Hills. The lack of fire and other disturbances in the uplands surrounding Beaver Gulch has resulted in an increased density of ponderosa pine and may be expected to have reduced groundwater flows and base flows throughout the watershed. At present, fire as a management tool in the immediate vicinity of the known population of variegated scouring rush itself is not appropriate as the fire tolerance and ecology of the species is not well understood (USDA FS RMRS 2001). As more is learned about the species, prescribed fire may offer an appropriate management tool based on the apparent needs of this plant to colonize disturbed sites, and potential benefits that may be derived from lower amounts of competing vegetation.

### **Fire Suppression**

Fire suppression is known to promote expansion of coniferous forest in the Black Hills as noted earlier, contributing to widespread reduction of water yields and stream flows over historic conditions. These hydrologic effects may adversely affect variegated scouring rush, which requires moist conditions through various stages of its life history.

### **Non-Native Plant Establishment And Control**

There is no specific information available for variegated scouring rush, although it may not compete well with aggressive species capable of exploiting its habitat, such as Canada thistle (*Cirsium arvense*).

### **Fuelwood Harvest**

The steep slopes and inaccessibility of the canyon bottom suggest that fuelwood harvest would not pose a serious risk to the known variegated scouring rush population.

### **Road Construction**

Logging activities in the 1990's included road construction into the previously roadless area separating Beaver and Bear Gulches (Ode pers. comm. 2001). Additional road building and improvement along ridge crests beyond the Botanical Area is permitted under the Forest Plan (USDA Forest Service 1997) and may impact variegated scouring rush as noted under Timber Harvest.

### **Other**

Collection of plant specimens is not likely to pose a risk. Although the species may appeal to some amateur botanists, it is not likely to be sought after by the general public.

### ***Natural Disturbance***

### **Insect Epidemics**

No information is available regarding direct impacts to variegated scouring rush. Indirectly, insect epidemics that kill upland conifers might benefit variegated scouring rush through enhanced water yield.

### **Wildfire**

No information is available regarding direct impacts to variegated scouring rush. Indirectly, wildfires that kill upland conifers might benefit variegated scouring rush through enhanced water yield, although the precise role of fire in Black Hills ecology remains a controversial topic.

### **Wind Events**

Wind events are not expected to pose a significant risk to variegated scouring rush, and may benefit the species by toppling woody species that may encroach into potential habitat, and by providing new recruitment sites.

### **Flooding**

Variegated scouring rush is apparently adapted to and dependent on inundation, fluvial disturbance, and/or saturated soils. Adverse impacts due to intense, large flooding events are possible due to the in-channel position of portions of the occupied habitat. The area above Beaver Gulch has been logged in recent times. Future logging in the area may be of potential concern from the standpoint of high runoff, and the increased potential for intense, large flooding events floods, but increased physical disturbance may also create new recruitment opportunities for variegated scouring rush.

### **Other Events**

It is unknown whether prolonged drought may adversely impact variegated scouring rush.

## **REVIEW OF CONSERVATION PRACTICES**

### **Management Practices**

The Bear/Beaver Gulch Botanical Area was designated in 1997, and is administered by the Northern Hills Ranger District, Black Hills National Forest (USDA Forest Service 1997). No specific management practices have been applied in the Black Hills or elsewhere for variegated scouring rush. Many potentially beneficial management practices are already incorporated in the Forest Management Plan for the Botanical Area, arising from a central theme to “protect unusual or special characteristics” (USDA Black Hills National Forest 1996). However, road construction, timber harvest, livestock use, and mineral development are permitted within the watershed, beyond the boundaries of the Botanical Area. All potential projects within the Botanical Area are required to be designed to avoid impacts to the existing population of variegated scouring rush. Restoration of “fire to its natural role in the ecosystem” on surrounding uplands in the vicinity with other potential habitat may improve water yield and site hydrology, and potentially create new recruitment sites, although this is not known for certain (USDA Black Hills National Forest 1996). Because so little is currently known about the ecology of these species, it is not possible to determine the degree of risk that disturbance and

management activities present. There are no apparent ongoing impacts to the species, but the currently known locations are small enough that random stochastic disturbance could eradicate a population entirely.

Non-administrative vehicles and off-road vehicles are restricted from the Bear/Beaver Gulch Botanical Area (USDA Black Hills National Forest 1996). Snowmobiles are permitted in the area but the only conceivable snowmobile trail through this portion of Beaver Gulch is along the valley bottom trail which is generally inaccessible from existing logging roads due to steep forested side slopes. As noted earlier, snowmobiling is not expected to be a significant risk to the species. Variegated scouring rush is not used for any known commercial purposes or as a special forest product.

In seep and wetland habitats such as the documented EO for variegated scouring rush, conservation requires the maintenance of groundwater flow, water chemistry, and the structure and integrity of the vegetation (Reed 1985). Because the sources of groundwater flow and recharge areas for seeps are often difficult to determine, management activities may need to focus on adjacent land use so that sources of groundwater draw down and/or contamination may be eliminated or reduced (Reed 1985).

The critical role of fire as a natural disturbance mechanism at the landscape scale has been documented in the Black Hills and elsewhere. Prescribed burning is widely recommended for the conservation of wetland vegetation (Reed 1985). Any prescribed burn plan of the Bear/Beaver Botanical Area would be for the purpose of maintaining or conserving the botanical values for which the BA was designated, which include designing burn plans that could benefit variegated scouring rush. Although published information on the effect of fires on variegated scouring rush is limited, many wetland habitats in the region most likely evolved with intense fire disturbances in the past (Parrish *et al.* 1996; USDA FS RMRS 2001). Improved water yield may be expected to favor recruitment and maintenance of early seral species such as variegated scouring rush. Logging activities within the Beaver Gulch watershed above the Botanical Area may offer similar benefits to fire in terms of improved water yield.

## **Models**

GIS based habitat level modeling may be appropriate for variegated scouring rush to identify and prioritize surveys of potential habitat areas. Because of limited occurrence data about the plant and its habitat preferences in the Hills, steep-walled canyons on the north slope of the Black Hills could be an appropriate starting point for additional surveys, although other suitable potential habitat areas may also exist.

## **Survey And Inventory Approaches**

Surveys of Black Hills vegetation have primarily been conducted at the project level that have included the use of Ranger District personnel, through agreements with The Nature Conservancy and by contracts. If future data is collected by the Forest for this species it is currently anticipated that it will be stored in the Forest database and the Forest GIS system. Copies of any data collected will be sent to the respective State Natural Heritage Program. Any vouchers collected will be sent to the designated FS herbarium for vouchers in the Rocky Mountain Region, which is currently the Rocky Mountain Herbarium in Laramie, Wyoming.

Portions of Beaver Gulch and Bear Gulch drainages were surveyed for sensitive plant species during 1989 (Ode and Marriott 1990). Variegated scouring rush was collected on an incidental basis during those surveys, but has not been the focus of specific surveys (Marriott pers. comm. 2001). Potential habitat for variegated scouring rush is likely to be present in other north slope drainages, from Thompson Gulch to Fish Hatchery Gulch, and possibly beyond (Marriott pers. comm. 2001). Potential habitat could be mapped and prioritized for surveys.

## **Monitoring Approaches**

A monitoring design specific to this species is unknown and monitoring of variegated scouring rush by the Black Hills National Forest has not been performed to date. A simple approach of estimating colony size and density, and mapping boundaries of the known colony (ies) via GPS, could provide important baseline data. Follow-up monitoring may be repeated every few (e.g., two to five) years.

This monitoring approach can also be applied to future surveys if other EO's are found. Potential habitat where the species is not found during future surveys could also be identified and survey routes mapped via GPS. Periodic resurveys (e.g., every 10 years) may then be conducted to determine if new recruitment occurs. If additional EO's are identified, the monitoring frequency may be modified accordingly.

## **ADDITIONAL INFORMATION NEEDS**

Additional ongoing data collection could focus initially on comprehensive surveys and inventories to better assess the range and distribution of variegated scouring rush on Black Hills National Forest. Additional surveys of potential habitat areas could be conducted in other northern Black Hills drainages including Bear Creek, and from Thomas Gulch to Fish Hatchery Gulch. Documentation of known element occurrences could include mapping via GPS (e.g., area type polygon of known population boundaries with survey grade GPS unit), estimates of colony size and density, and collection of other basic biotic and abiotic data such as geology, hydrology, associated species and community types. Voucher specimens could be collected for any new populations of variegated scouring rush to ensure proper identification. On a broader scale, studies to quantify water yield improvements as a result of prescribed burns and logging could provide additional information.

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## DEFINITIONS

### THE NATURE CONSERVANCY NATURAL HERITAGE RANKS

GLOBAL RANK (G): based on range-wide status of a species

- G1 Critically imperiled globally because of extreme rarity (5 or fewer occurrences, or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range).
- G2 Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range).
- G3 Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences). (Threatened throughout its range).
- G4 Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.
- G5 Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
- GX Presumed extinct
- GQ Indicates uncertainty about taxonomic status.
- GU Unable to assign rank due to lack of available information.
- G? Indicates uncertainty about an assigned global rank.

TRINOMIAL RANK (T): used for subspecies or varieties. These taxa are ranked on the same criteria as G1-G5.

STATE RANK (S): based on the status of a species in an individual state. S ranks may differ between states based on the relative abundance of a species in each state.

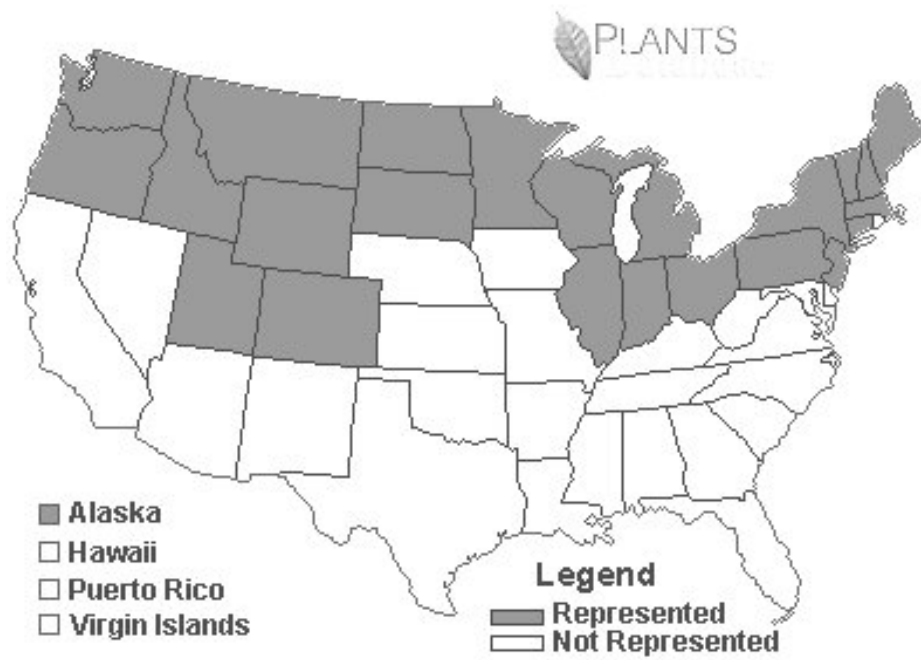
- S1 Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the state. (Critically endangered in state).

- S2 Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the state. (Endangered or Threatened in state).
- S3 Vulnerable in state (21 to 100 occurrences).
- S? Indicates uncertainty about an assigned state rank.

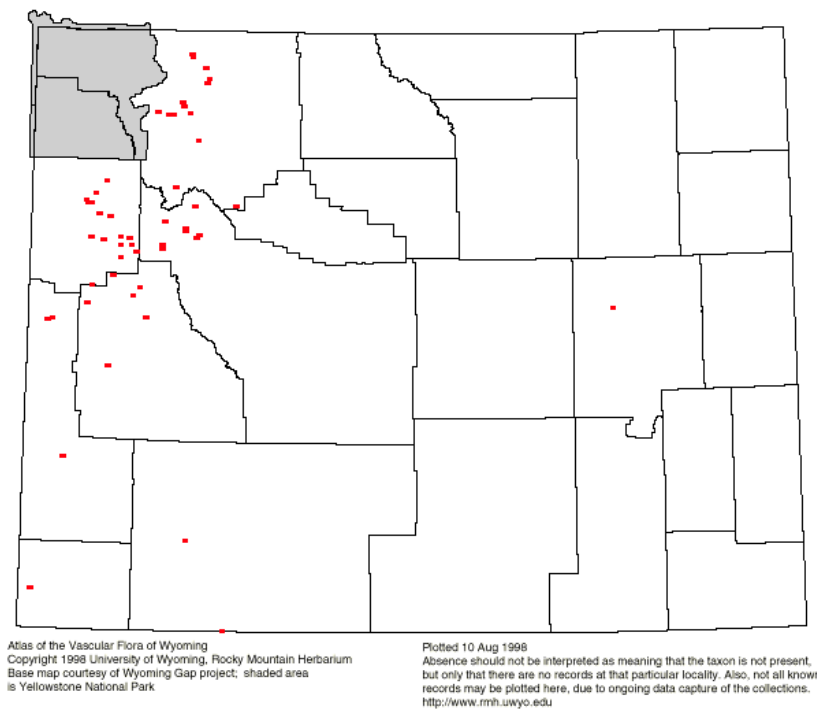
## FIGURES

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**Figure 1.** U.S. distribution for variegated scouring rush (USDA, NRCS 2001). Grey areas indicate confirmed presence.



**Figure 2.** Wyoming distribution for variegated scouring rush (University of Wyoming 1998).



**Figure 3.** Photograph of variegated scouring rush habitat, Beaver Gulch (Glisson 2001).



**Figure 4.** Close-up photograph of variegated scouring rush showing co-occurrence with redtop bent (*Agrostis stolonifera*) (Glisson 2001).

